

FINAL REPORT
POLYSTYRENE RECYCLING

DECEMBER 1993



**Ministry of
Environment
and Energy**

ISBN 0-7778-0861-7

FINAL REPORT: POLYSTYRENE RECYCLING

DECEMBER 1993



Cette publication technique
n'est disponible qu'en anglais.

Copyright: Queen's Printer for Ontario, 1993
This publication may be reproduced for non-commercial purposes
with appropriate attribution.

PIBS 2338

**FINAL REPORT:
POLYSTYRENE RECYCLING**

Report prepared by:

Canadian Polystyrene Recycling Association

Report prepared for:

Waste Management Branch
Industrial Waste Diversion Program
Ontario Ministry of Environment and Energy

DISCLAIMER

This report was prepared for the Ontario Ministry of Environment and Energy as part of a ministry-funded project. The views and ideas expressed in this report are those of the author and do not necessarily reflect the views and policies of the Ministry of the Environment, nor does mention of trade names or commercial products constitute endorsements or recommendation for use.

TABLE OF CONTENTS

	Page
1. Executive Summary	1
2. Introduction	2
. Purpose of report	3
. Summary of April 1991 Submission	3
3. The Mississauga Facility	
a. Feedstock Collection	
i) Original 1990/91 Estimate	6
ii) Revised Estimates	7
iii) 1991/92 Collection Results	11
b. Process Operations	
i) Capital Costs	11
ii) Installation & Commissioning	13
iii) Material Handling	13
iv) Washing & Drying	14
v) Extrusion & Pelletizing	16
vi) Health and Safety	16
vii) Operating Costs	17
c. Marketing the Resin	
i) Sales Agreements	18
ii) Product Description	18
iii) Results to Date	18

4. Conclusions

i)	Collection Plans and Strategies	20
ii)	Processing and Marketing	21

Appendixes

Appendix A -	Current CPRA Member Companies
Appendix B -	Progress Report to Ministry of the Environment
Appendix C -	CPRA Product Descriptions
Appendix D -	Recommended Capital Equipment - CPRA Mississauga Plant

Tables

Table 1 -	MOE Capital Funding - Mississauga Plant
Table 2 -	Estimated Provincial Polystyrene Usage and Availability
Table 3 -	Total Estimated Polystyrene Demand (Revised)
Table 4 -	Monthly Collection Report

EXECUTIVE SUMMARY

In February 1992, CPRA signed an agreement with the Ministry of the Environment whereby the Ministry agreed to pay a grant to CPRA of up to \$575,150, covering eligible capital and installation costs for polystyrene recycling equipment at CPRA's Mississauga recycling facility. The purpose of the facility is to provide a state of the art polystyrene recycling capability for all types of polystyrene produced and used in the Canadian market. The plant is approximately 80,000 square feet, and contains processing equipment capable of sorting, granulating, washing, drying, extruding and pelletizing both contaminated food service polystyrene containers and clean, dry polystyrene cushion and rigid packaging and containers. Total annual processing capacity is approximately 5,000 tonnes per year.

The plant commenced operations in August 1991. In 1991, CPRA collected and processed a total of 323,000 pounds of polystyrene plastics, comprising 276,000 pounds of packaging material and 47,000 pounds of food service foam and rigid containers. In 1992, CPRA's collection target is 2,078,920 tonnes, comprising 1,800,000 pounds of EPS and rigid packaging, 155,460 pounds of food service packaging, and 123,460 pounds from municipal collection programs. To date, (September 1992) CPRA has collected a total of 1,313,677 pounds.

CPRA has established a marketing program for its recycled polystyrene resin, through sales agreements with Dow Chemical Canada Inc. and Novacor Chemicals (Canada) Ltd. which provide CPRA with the use of these companies market development, sales and customer technical service resources. Five basic grades of recycled resin products have been established. To date, more than 140 tonnes of recycled resin has been sold, primarily to manufacturers of extruded sheet and office products.

CPRA has conducted a detailed evaluation of the Mississauga plant's processing capabilities, and an analysis of existing and future market demand for reprocessed resin. As a result, CPRA's Board of Directors is examining a three-phased capital expansion program for the Mississauga plant, totalling an estimated \$790,000. This would provide improved through-put capability, and increase the plant's capacity for handling a wide range of polystyrene plastic products.

INTRODUCTION

The Canadian Polystyrene Recycling Association (CPRA) is a non-profit corporation, established in 1989 by letters patent under the provisions of Part II of the Canada Corporations Act. The objects of the corporation are to undertake the establishment, operation and development of facilities for the recycling of products manufactured from polystyrene plastics; to undertake studies and research concerning polystyrene recycling; and to promote consumer participation in polystyrene recycling by all means available.

Membership in the Association consists of those persons or corporations, associations, partnerships or other organizations interested in furthering the objects of the corporation. Applications for admission as a member must receive approval of the Board of Directors of the corporation. A complete list of present members of the Association is contained in Appendix A.

In July 1990, CPRA submitted a proposal to the Ontario Ministry of the Environment, requesting funding assistance under the Ministry's Industrial Waste Diversion Program. That proposal was supplemented with an updated, more detailed submission in April, 1991.

In February 1992, CPRA signed an agreement with the Ministry of the Environment whereby the Ministry agreed to pay a grant to CPRA of up to \$575,150 covering eligible capital and installation costs for polystyrene recycling equipment at CPRA's Mississauga facility. That amount was subsequently amended, following submission of final invoices, to a total of \$564,598. (See Table 1)

In accordance with the terms and conditions of the agreement, CPRA was required to submit a progress report during the operating and monitoring period of the project (January 1, 1991 - September 1, 1992), and a final report no later than December 31, 1992. Appendix B contains a progress report submitted to the Ministry in May 1992 to date.

Purpose of this Report

The purpose of this document is to submit a final report documenting the progress of the Mississauga plant, and results and conclusions which can be presented to the Ministry at this time.

Summary of 1991 Submission to Ministry of the Environment's Industrial Waste Diversion Program

CPRA's 1991 submission to the Ontario Ministry of the Environment requested funding assistance under their Industrial Waste Diversion Program for eligible capital and installation costs associated with CPRA's Mississauga's polystyrene recycling facility. Those costs, the total amount of financial assistance requested, and the Ministry's decision on these funding requests are summarized in Table 1.

The purpose of CPRA's Mississauga facility is to provide a state-of-the-art polystyrene recycling capability for all types of polystyrene produced and used in the Canadian market. The plant is approximately 80,000 square feet, and contains processing equipment capable of sorting, granulating, washing, drying, extruding and pelletizing both contaminated food-service polystyrene containers, and clean, dry polystyrene cushion and rigid packaging and containers. Total annual processing capacity is approximately 5,000 tonnes per year.

CPRA's 1991 submission to the Ministry also contained requests for the funding of a research and development program, aimed at refining and expanding CPRA's post-consumer collection and processing capabilities, investigating ways to enhance polymer properties and resale value of products produced at the Mississauga plant and investigation of foam densification techniques to improve equipment and labour utilization. Total cost of the R & D program were estimated at \$234,689. The Ministry requested submission of the R & D costs as a separate issue.

TABLE 1

CANADIAN POLYSTYRENE RECYCLING ASSOCIATION

MOE CAPITAL FUNDING - MISSISSAUGA PLANT

ELIGIBLE EQUIPMENT	ORIGINAL ESTIMATE	ACTUAL COST	ELIGIBLE COST	MOE PAYMENT	REMAINING BALANCE
A. PROCESS EQUIPMENT					
1. Storage & Sortation Equipment	\$108,090	\$109,591	\$109,591	\$27,400	0
2. Wet Granulator	72,000	72,017	72,017	18,005	0
3. Washer C/W Distribution Auger	115,000	121,382	121,382	30,345	0
4. Centrifugal Dryer	113,500	111,360	111,360	27,840	0
5. Oven	254,000	231,178	231,108	57,777	18
6. Baghouse	25,000	47,068	47,068	11,765	0
7. Silos & Conveyors	110,000	110,786	110,144	27,536	159
8. Air Compressor	18,000	14,400	14,400	3,600	0
9. Compressed Air Piping	8,000	6,485	6,485	1,620	0
10 Start-up Commissioning & Vendor Supervision	25,000	33,467	33,467	8,365	0
B. PIPING AND VALVES					
11. Process Piping and Valves	47,000	57,730	57,730	14,435	0

TABLE 1
(Continued)

PROCESS EQUIPMENT	ORIGINAL ESTIMATE	ACTUAL COST	ELIGIBLE COST	MOE PAYMENT	REMAINING BALANCE
C. BUILDING SERVICES					
12. Makeup Air Units, Fan etc.	96,000	73,995	73,995	18,500	0
13. Ductwork	47,000	59,161	59,161	14,790	0
14. Electrical	220,000	217,906	217,906	54,475	0
15. Controls & Instrumentation	109,000	197,097	197,097	49,275	0
D. POST CONSUMER LINE INDIRECT COSTS					
16. Engineering	320,000	360,000	360,000	90,000	0
17. Project Management	30,000	18,360	1,140	285	4,305
E. INDUSTRIAL (EPS) PROCESS LINE COSTS					
18. Grinder	119,500	117,875	117,875	29,470	0
19. Extruder	385,000	318,201	316,454	79,115	435
20. Crammer	58,500	0	0	0	0
21. Conveying	7,000	0	0	0	0
22. Platforms, Sorting Tables	13,000	0	0	0	0
TOTAL	\$2,300,590	\$2,278,059	\$2,258,380	\$564,598	\$4,917
HOLDBACK				\$50,000	
TOTAL, FIRST PAYMENT				\$514,598	

THE MISSISSAUGA FACILITY

A) Feedstock Collection

i) Original Estimates

In CPRA's original submission to the Ministry, it was estimated that the total production of polystyrene in Canada in 1988 amounted to approximately 158,000 tonnes, of which 31,000 tonnes were exported: 127,000 tonnes of domestically produced polystyrene were therefore used in Canada that year. It was further estimated that over 48,000 tonnes of polystyrene were imported into Canada in that year, resulting in an estimated total Canadian demand of 175,535 tonnes.

These figures did not include consideration of polystyrene packaging that enters or leaves Canada as a packaging product in use. Following discussions with representatives in the packaging industry and the plastic recyclers, CPRA consultants estimated that there appeared to be a net polystyrene import into Canada of approximately 35,000 tonnes per year.

In total, therefore, an estimated 210,535 tonnes of polystyrene were used in Canada in 1988.

CPRA's consultants then estimated the amount of polystyrene available for recycling. It was recognized that not all polystyrene is recoverable, and levels vary in the recycling of recovered recoverable polystyrene depending on geographic location and activity of polystyrene generation. It was proposed that recycling targets of 50% of consumer packaging, (including food services packaging and service ware) and 75% of industrial packaging be achieved by the end of 1993. This resulted in estimated provincial polystyrene usage and availability, as summarized in Table 2.

It was emphasized that recycling targets need to be viewed as milestones, towards eventual goal that all discarded polystyrene be managed through recycling. As successes achieved in recycling polystyrene, target strategies will need to be reviewed to ensure progress towards this goal.

ii) Revised Estimates

In 1992, CPRA reexamined these estimates, particularly the estimates of total amount of polystyrene produced and used in Canada. It did so by comparing results to date with original estimates, consulting with generators, and reviewing data available from research completed for the Quick Service Restaurant Council.

As a result, CPRA lowered its estimate of polystyrene produced and used in Canada, from 210,000, to approximately 150,000 tonnes annually. Of this amount, approximately 82,000 tonnes are in the form of disposable products. (See Table 3)

Estimates of EPS industrial feedstock from large volume generators have been lowered to approximately 6,300 tonnes (exclusive of imports), from original estimates of 41,000 tonnes (inclusive of imports). CPRA has not been able to estimate the amount of capturable EPS industrial feedstock imported into Canada by large volume generators.

Estimates of available food service containers have been adjusted to 49,000 tonnes, approximately 60% of CPRA's estimates of capturable disposable products. Original estimates were in the order of 38% of disposable.

To summarize:

- 1) Clean industrial EPS feedstock from large volume generators appears not to be available in quantities originally estimated however, there appear to be significantly higher quantities of high impact (rigid) polystyrene packaging material.
- 2) Curbside collection programs appear to be more significant, as revised estimates indicate a higher percentage of feedstock material available from the residential area.
3. Revised estimates of available food service containers appear to be higher then originally assumed.

TABLE 2**ESTIMATED PROVINCIAL POLYSTYRENE USAGE AND AVAILABILITY****(tonnes, 1988)**

Province	Estimated Usage	Estimated Availability for Recycling
Newfoundland	4,063	3,315
Nova Scotia	6,341	5,185
Prince Edward Island	920	750
New Brunswick	5,202	4,250
Quebec	55,772	47,000
Ontario	80,224	67,950
Manitoba	7,760	6,400
Saskatchewan	7,610	6,250
Alberta	8,296	15,100
British Columbia	23,709	19,800
Northwest Territories	552	450
Yukon Territories	186	150
TOTAL	210,535	176,500

NOTE: . Estimates assume that polystyrene usage is proportional to population and industrial distribution.

. Polystyrene used in durable goods assumed to be unavailable for recycling

TABLE 3

TOTAL ESTIMATED POLYSTYRENE (CANADA)

(REVISED)

(tonnes)

	MACLAREN - 1990/91	CPRA - 1992
Total Polystyrene Demand (Canada 1991)	210,535*	150,000
Durable Products	65,000 (31%)	67,650 (45%)
Disposable Products	145,000 (69%)	82,350 (55%)
A. Food Service	A. 55,000	A. 49,000
B. Rigid Packaging	B. N/A	B. 27,000
C. EPS Packaging	C. 41,000*	C. 6,350

* Includes estimated 35,000 tonnes of imported EPS packaging.

iii) 1991/92 Collection Results

Based on revised estimates, CPRA established a 1992 collection goal of 1,755,065 pounds of feedstock to be collected in the Mississauga Plant.

In March 1992, that goal was revised upwards to 2,078,920 pounds, to be comprised of:

- . 1,800,000 pounds of EPS and rigid packaging
- . 123,460 pounds from Blue Boxes
- . 155,460 pounds from food service

Table 6 documents monthly collection results, compared to budget, as of September 1992. These results indicate that food service collection is running well ahead of original targets, that industrial and EPS is approximately on target, and that blue box collection material is significantly below target.

B) PROCESS OPERATIONS

i) Capital Costs

Table 1 summaries the capital expenditures for engineering, equipment and installation supported under the grant from the Ministry. The total capital cost, including those items not eligible under the provisions of the grant was \$2,278,059.

The installed equipment provides CPRA with the capacity to recycle food service disposable items, municipal curbside material, and industrial/commercial feedstocks.

TABLE 4
MONTHLY COLLECTION REPORT
SEPTEMBER 1992 (POUNDS)

MONTH	FOOD SERVICE		BLUE BOX		INDUSTRIAL		TOTAL	
	Budget	Actual	Budget	Actual	Budget	Actual	Budget	Actual
January	6,520	7,694	500	0	80,000	99,782	87,020	107,476
February	7,690	9,226	500	8,818	85,500	38,900	93,690	56,944
March	8,860	15,399	10,140	992	91,550	163,750	110,550	180,141
April	10,030	22,385	10,140	0	134,190	104,197	154,360	126,582
May	11,200	12,714	10,140	540	141,510	115,685	162,851	128,939
June	12,370	22,006	10,140	13,517	149,563	108,133	172,073	143,656
July	13,540	14,639	13,650	0	158,421	177,290	185,611	191,929
August	14,710	15,730	13,650	0	168,164	127,611	196,524	143,341
September	15,880	16,193	13,650	0	178,882	218,476	208,412	234,669
October	17,050		13,650		190,672		221,372	
November	18,220		13,650		203,641		235,511	
December	19,390		13,650		217,906		250,946	
YEAR TO DATE TOTAL	155,460	135,986	123,460	23,867	1,800,000	1,153,824	2,078,920	1,313,677

ii) Installation & Commissioning

Tender documents covering the installation of equipment in the facility were prepared by MacLaren Engineers. Five proposals from Ontario general contractors were received. The Naylor Group of Oakville was selected as the general contractor.

Mechanical, electrical, instrumentation and process piping work was completed by Naylor and the various sub trades in August 1991.

The first recycled resin was generated on August 22, 1991 and the plant was fully commissioned and in operation within four weeks of that date.

iii) Material Handling

CPRA receives recyclable polystyrene in a diversity of containers including:

- . pre-sorted, baled post consumer curbside materials
- . loose, bagged post consumer food service products
- . baled industrial foam packaging
- . loose industrial foam packaging
- . loose & packaged rigid polystyrene items

Transportation methods include:

- . roll off waste containers up to 40 cubic yards capacity
- . conventional tractor/trailers
- . front end loading packer truck
- . cube van

Upon receipt materials are inspected, weighed and classified.

Further inspection and sorting is conducted on a series of conveyors that are designed to break bales, distribute materials to facilitate sorting, and deliver products to downstream processing equipment.

Two significant bottlenecks are occurring in the material handling process:

- . low density materials are difficult to move from the tipping floor onto the conveying equipment.
- . large EPS blocks must be manually reduced in size to prevent "log jams" of material at the granulator throat.

CPRA is currently investigating methods to increase the automation of the material handling systems.

iv) Washing & Drying

Post consumer food service and municipal curbside materials must be washed to remove undesirable residues, and dried to condition the product for feeding to the extruder.

This is accomplished in four steps:

1. Wet Granulation

The pre-sorted contaminated materials are fed to a wet granulator where they are reduced, in the presence of a water flow, to a flake of approximately 0.750" in diameter. This serves three purposes:

- a) The vigorous action of the granulator releases contaminants from the polystyrene into the water stream.
- b) A large surface area is created for more efficient washing in step two.
- c) The material is properly sized for feeding to the extruder.

2. Counter Current Washing

Granulated flakes are pneumatically conveyed from the wet granulator to the counter current washing tunnel. In this unit the material is subjected to agitation in a cold water bath. The washer consists of 11 washing stages. Material is forwarded through each stage on a timed cycle, during which a counter flow of wash water occurs

Clean water is introduced in the last stages of the washer, resulting in a clean water rinse, and minimization of water consumption in the process.

3. Centrifugal Dryer

Material discharged from the washer is mechanically conveyed to a centrifugal dryer that removes surface moisture by a combination of centrifugal force and impingement of material against a perforated screen. Exiting this dryer, the polystyrene may contain up to 50% water by weight.

4. Fluid Bed Dryer

Damp polystyrene from the centrifugal dryer enters the fluid bed dryer. Vibration and air movement create a fluidized bed of polystyrene. The fluidizing air is heated by means of a direct fired gas heater and serves to dry the material to less than 1% moisture.

v) Extrusion & Pelletizing

The final step of the recycling process involves heating the polymer above its melting point in a single screw, two stage extruder. During this process the cleansed and granulated polystyrene is densified, air and volatiles removed, and filtered through a series of wire screens. Lastly, the polymer is forced, under high pressure, through a pelletizing die and cut into 1/8" pellets in a water ring pelletizer. The cut pellets are cooled in a water sluice, dried and classified to ensure consistent geometry.

The extrusion and pelletizing equipment was selected to provide maximum processing flexibility and is capable of handling all grades of polystyrene feedstocks ranging from expanded polystyrene to rigid high impact materials.

vi) Health and Safety

CPRA has developed a comprehensive programme designed to meet or exceed the requirement of the Occupational Health and Safety Act.

Audiometric testing is provided for all employees. Where sound level surveys have indicated noise levels exceeding 85 dBA additional engineering controls have been provided.

Routine spot testing for styrene monomer has produced results well under the levels prescribed by Provincial regulation. Dosimeter tests confirm employee exposure levels to regulated agents are well within the acceptable range.

Special testing for odour emissions required under the Section 8, Air Emissions Certificate was conducted by Ortech International and results were submitted to the Ministry of the Environment.

CPRA's laboratory capabilities include measurement of waste water quality. Wash water is routinely measured for C.O.D., pH, and suspended solids.

Testing by the Region of Peel confirms our own analyses that waste water quality consistently meets municipal standards.

vii) Operating Costs

Fixed costs associated with the recycling facility represent a significant portion of the total operating costs.

Consequently, the relatively low capture rates experienced to date have resulted in losses exceeding the budget over the first twelve months of operation.

Reduction of operating costs to acceptable levels can be achieved through increased volume and production rate improvements, primarily in the area of material handling and contamination removal.

To this end procurement activities directed at specific large volume polystyrene generators in the IC & I sector have been implemented, and engineering has started on process upgrading this is described in more detail in the conclusion of this report, and Appendix D.

MARKETING THE RESIN

i) Sales Agreements

CPRA has entered into separate agreements with Dow Chemical Canada Inc. and Novacor Chemicals (Canada) Limited to market its recycled polystyrene resin domestically and internationally as exclusive agents of CPRA.

Through these agreements, the expert market development, sales and customer technical service resources of two of Canada's foremost petrochemical suppliers are focused on the development of sustainable markets for CPRA's product line. These agreements provide that CPRA maintains product ownership and control over the product slate.

ii) Product Description

CPRA produces five basic grades of recycled resin, differentiated by colour, end use applications, physical properties and raw material source.

Technical data on each grade is presented in Appendix D.

iii) Results to Date

CPRA's approach to market development has been to focus on value-added, sustainable markets which meet the following criteria:

- . added value for recycled content
- . durable goods produced
- . non food contact application
- . on going demand for resin

To date the market has been slower than anticipated. A number of factors contribute to this response, including:

- . depressed market conditions
- . low virgin and off grade pricing
- . lack of market demand -- both pull-through as well as push-through -- for recycled content products
- . converters concerned over impact of recycled resin on product performance and production costs
- . length of time needed to conduct product evaluations

Nevertheless, CPRA has to date sold over 140 tonnes of recycled resin, primarily to manufacturers of extruded sheet, office products and to some international brokers seeking repro material.

CONCLUSION

Since September 1991, CPRA has been collecting and processing all types of polystyrene plastics at its Mississauga Plant, from over two hundred IC & I locations, and 40,000 households through Municipal Blue Box programs. During this period of time, CPRA has regularly evaluated its collection plans and strategies, conducted a careful review of its processing operations and capabilities, and examined existing and potential markets for its reprocessed resin material. This has enabled CPRA to draw a number of conclusions from its first year of operating the Mississauga Plant.

A) Feedstock Collection Program

Based on 1992 results to date, and projected year end volumes, CPRA believes it will achieve approximately 90% of its 1992 forecasted feedstock collection volume, broken down as follows: approximately 123% of its food service target, 90% of its industrial target and 28% of its blue box target.

CPRA's revised estimates on available feedstock material indicate that, while there appears to be less available EPS cushion packaging than originally estimated, there are significantly larger quantities of high impact polystyrene material, primarily in the retail shopping plaza sector. In addition, rigid and high impact polystyrene packaging material is available in higher quantities than original estimates in the retail drug and cosmetic sectors, and media/promotional advertising sectors.

CPRA has been pleased with the growth of its food service collection program, now operating in a wide range of food service establishments, including industrial cafeterias, University and Community College cafeterias, food-courts in retail shopping malls, recreational centres, sports complexes and some fast food franchise operations. CPRA's full time collection staff have been working through Ontario's waste recycling and haulage network to assist generators in

establishing and monitoring their collection programs. Contamination rates at the Mississauga Plant have been lower than expected, and average approximately 20% (by weight), from food service locations.

Based on a survey with a small sample of CPRA customers, it appears that the primary motivation for participation in the program is good corporate citizenship, not economics. However, economics become an important, often deciding factor for many medium (90 pounds per month) to small (25 pounds per month) generators, making haulage and tipping fees deciding factors in determining whether or not generators adopt a recycling program.

The fast food sector represents an important target sector for CPRA, and CPRA will be focusing increased efforts in this area in 1993. In addition, it is estimated that approximately 3,000 tonnes of polystyrene could be recoverable from households in the Greater Toronto Area alone. However, logistics of separating residential polystyrene at most existing Municipal Recycling Facilities are a major obstacle. The proposed SORTCO facility, currently being examined by a coalition of plastic resin producers and converters, would have a major impact on the potential for widespread polystyrene recovery from the residential sector in Ontario.

B. Processing and Marketing

Over the past twelve months, CPRA's Technical Committee has conducted a detailed evaluation of the Mississauga plant's processing capabilities, and an analysis of existing and future market demand for reprocessed resin. In essence, CPRA's objective at its Mississauga Plant is to produce finished products which meet market requirements in sufficient quantities, at lowest possible processing costs.

CPRA began this process by first looking at the market for reprocessed resin, and identifying the requirements which must be met if CPRA is to obtain a competitive price for its products. This analysis indicated that CPRA must provide homogeneous lots of finished product along with a product which has consistent colour, physical properties and processing characteristics, together with low contamination levels.

The analysis then turned to the Mississauga Plant processing capabilities, and the identification of process improvements which would enable the plant to process an annual capacity sufficient to support a break even operation, at foreseeable selling prices.

This analysis showed that at current production rates and foreseeable selling prices, processing costs cannot be absorbed without affecting process improvements. Additional equipment is required to remove material handling bottlenecks, effectively remove contaminants from some proposed feedstocks, and provide capacity to blend finished products in large homogeneous lots. Installation of this equipment is required to meet market demand for product consistency and properties, and to reduce processing costs of industrial material below direct costs incurred in production.

As a result, capital expenditures have been recommended by CPRA's Technical Committee to the Board of Directors, for improving throughput capability for processing materials, and installing blending capability to enhance product consistency. These recommendations are summarized in Appendix D (Proposed Mississauga Plant Capital Expenditures), and are currently being reviewed by the Board of Directors.

However, in the final analysis the economics of this, or any recycling operation, are dependant on a market demand for the finished product.

Key to success is the creation of markets for products containing recycled materials, and the ability to recognize and react to changing demands for the product. Through its first year of operation CPRA has modified and upgraded its product slate in response to the needs of the industry and is working actively with its sales agents to promote and develop new markets. However, further market research will be needed to identify new applications for recycled polystyrene and ensure products meeting manufacturing specifications are available.

APPENDIX A

CURRENT CPRA MEMBER COMPANIES

ADELCO SUPPLY CO. INC.
GLENFORD PAPER DIVISION

LILY CUPS INC.

AIR CANADA

MARRIOTT CORPORATION OF
CANADA LIMITED

BEAVER FOODS LIMITED

MCDONALD'S RESTAURANTS
OF CANADA, LIMITED

CANADA CUP INC.

MOBIL CHEMICAL CANADA LTD.

CANADA PLASTIC
CONTAINERS LIMITED.

NOVACOR CHEMICALS
(CANADA) INC.

DAIRY QUEEN CANADA INC.

POLAR PLASTIC LTD.

DANA HOSPITALITY INC.

PORTION PACKAGING

DART CUP LIMITED

PRICE DAXION

DOW CHEMICAL CANADA INC.

SCOTT POLYMERS LTD.

ELDON-RUBBERMAID OFFICE
PRODUCTS

SERVIFOOD LIMITED

ENVIRONMENT AND PLASTICS
INSTITUTE OF CANADA

SHELL CANADA CHEMICAL
COMPANY LIMITED

FIBRACAN

VERSA SERVICES LIMITED

G. T. FRENCH PAPER LTD.

APPENDIX B

Interim Report to Ministry of the Environment

CANADIAN POLYSTYRENE
RECYCLING ASSOCIATION



ASSOCIATION DE RECYCLAGE
DU POLYSTYRÈNE DU CANADA

May 20, 1992

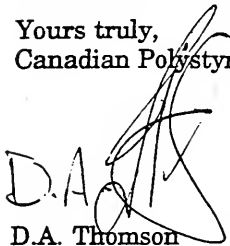
Ms. Nina S. Koskenoja
Project Engineer
Industrial 3Rs Unit
Waste Management branch
Ministry of the Environment
135 St. Clair Avenue West
Suite 200
Toronto, Ontario
M4V 1P5

Dear Ms. Koskenoja,

Enclosed please find quarterly report #2 as required in support of the grant provided under the Industrial Waste Diversion Program.

We trust you will find this satisfactory.

Yours truly,
Canadian Polystyrene Recycling Association


D.A. Thomson
Plant Manager

2.3 Results

Tables 3, 4, and 5 show the actual quantity of materials collected from each of CPRA's three major sources, with comparisons to the quantity forecast in the company's 1992 budget.

3.0 APPLICATION OF RECYCLED MATERIALS

CPRA has recently appointed Dow Chemical Canada Inc. and Novacor Chemicals (Canada) Limited as exclusive agents for the sale of recycled resins from the Mississauga plant.

The focus of the marketing effort is to develop sustainable sales for the production of durable goods.

Many of the applications under development involve lengthy testing and approval procedures. It is expected that more detailed application information will be available for publication in the final report.

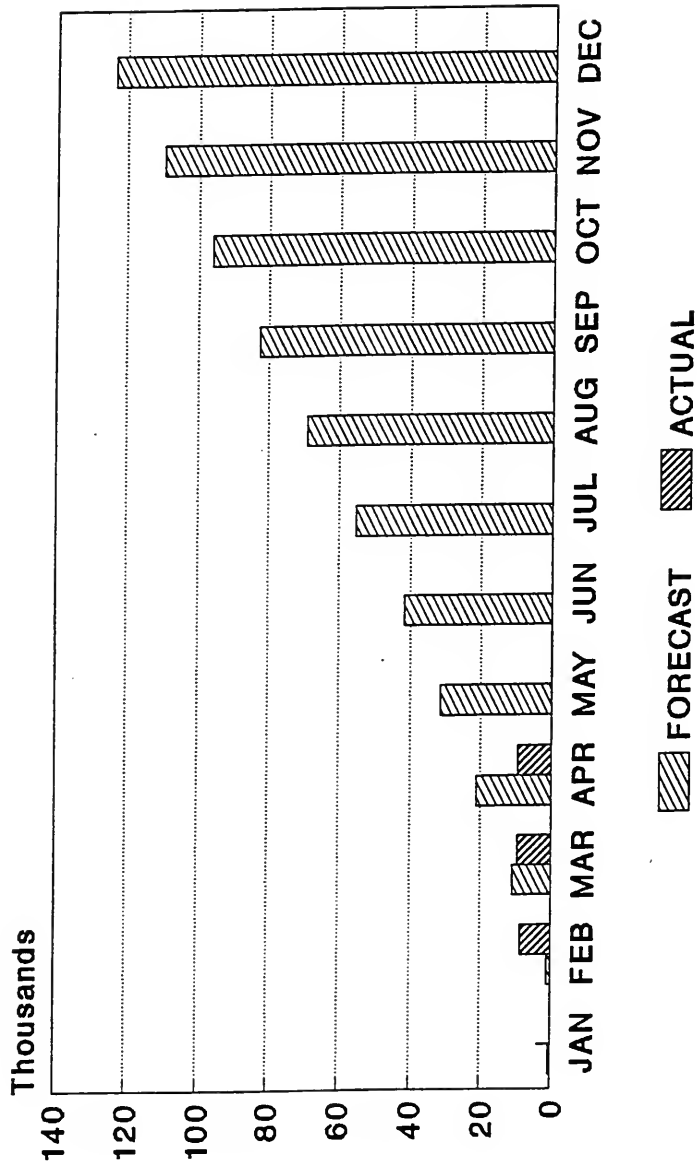
CPRA MONTHLY PROCUREMENT REPORT

TABLE 2

1992 Tonnage Numbers (lbs)	January	February	March	April	May	June	July	August	September	October	November	December
Food Service	7,694	9,226	15,399	24,193								
Blue Box	0	8,818	992	0								
Industrial Scrap	99,782	38,900	163,750	104,197								
Total	107,476	56,944	180,142	128,390								

BLUE BOX

1992



CUMULATIVE (POUNDS)

TABLE 4

APPENDIX C

CPRA Product Descriptions



Technical Data

Name: CPRA 100

Description: Recycled Polystyrene for injection moulding applications.

Colours - Black, Grey and White

Properties:

Item	Range	Unit	Method
Melt Flow Rate	7 - 12	g/10 min	ASTM D1238 200C/5.0 kg
Moisture	< 0.1	%	CPRA Test Method CPTM 002
Pellet Count	20 - 60	# / gram	CPRA Test Method CPTM 004
IZOD - Notched	0.4	ftlb/in	ASTM D256

Diversity of post consumer feedstocks may result in lot to lot variations of colour and appearance in moulded parts. The user must determine the suitability of the product for specific applications.

Date: August 20, 1992

Prepared by: Ian Churcher



Technical Data

Name: CPRA 200

Description: Recycled Polystyrene for injection moulding applications.

Properties:

<i>Item</i>	<i>Range</i>	<i>Unit</i>	<i>Method</i>
<i>Melt Flow Rate</i>	<i>20 - 40</i>	<i>g/10 min</i>	<i>ASTM D1238 200C/5.0 kg</i>
<i>Moisture</i>	<i>< 0.1</i>	<i>%</i>	<i>CPRA Test Method CPTM 002</i>
<i>Pellet Count</i>	<i>20 - 40</i>	<i># per gram</i>	<i>CPRA Test Method CPTM 004</i>

Diversity of post consumer feedstocks may result in lot to lot variations of colour and appearance in moulded parts. The user must determine the suitability of the product for specific applications.

Date: February 12, 1992

Prepared by: Ian Churcher



Technical Data

Name: CPRA 300

Description: Recycled Polystyrene for injection moulding applications.

Properties:

<i>Item</i>	<i>Range</i>	<i>Unit</i>	<i>Method</i>
<i>Melt Flow Rate</i>	<i>4 - 8</i>	<i>g/10 min</i>	<i>ASTM D1238 200C/5.0 kg</i>
<i>Moisture</i>	<i>< 0.1</i>	<i>%</i>	<i>CPRA Test Method CPTM 002</i>
<i>Pellet Count</i>	<i>30 - 60</i>	<i># per gram</i>	<i>CPRA Test Method CPTM 004</i>

Diversity of post consumer feedstocks may result in lot to lot variations of colour and appearance in moulded parts. The user must determine the suitability of the product for specific applications.

Date: February 12, 1992

Prepared by: Ian Churcher

CANADIAN POLYSTYRENE
RECYCLING ASSOCIATION



ASSOCIATION DE RECYCLAGE
DU POLYSTYRÈNE DU CANADA

SECTION V - FIRE EXPLOSION HAZARD

Conditions of Flammability: High Temperatures

Means of Extinction: Water fog, CO₂, Dry Chemical

Explosion Data

Sensitivity to Mechanical Impact: None

Sensitivity to Static Discharge: None

Flashpoint (°C) and Method: Not Tested

Upper Flammable Limit %: N/A

Lower Flammable Limit%: N/A

Autoignition Temperature (°C): Not Tested

Hazardous Combustion Products: Smoke and noxious gases, carbon monoxide and hydrocarbons

SECTION VI - REACTIVITY DATA

Stability: Temperatures in excess of 300°C release combustible gases

Incompatible Materials: None Known

Conditions of Reactivity: None

Hazardous Decomposition: Smoke and noxious gases, carbon monoxide, hydrocarbons

SECTION VII - TOXICOLOGICAL PROPERTIES

Route of Entry: Inhalation of dust or vapour may cause irritation to upper respiratory tract

Skin Contact

Skin Absorption

Eye Contact

Inhalation ✓

Ingestion

Effects of Acute Exposure to Product: None Known

Effects of Chronic Exposure to Product: None Known

Exposure Limits: Resin - None

Styrene - 50ppm TWA 8 hours 100ppm STEL

Irritancy to Product:

None Known

Synergetic Products:

None Known

Evidence of Carcinogenicity, Reproductive Toxicity, or Mutagenicity?: None Known

Sensitivity to Product: None

CANADIAN POLYSTYRENE
RECYCLING ASSOCIATION



ASSOCIATION DE RECYCLAGE
DU POLYSTYRENE DU CANADA

NOTICE: The information herein is presented in good faith and believed to be accurate as of the effective date shown above. However, no warranty, express or implied, is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state, or provincial, and local laws. The following specific information is made for the purpose of complying with numerous federal, state, or provincial, and local laws and regulations

APPENDIX D

Recommended Capital Equipment - CPRA Mississauga Plant

RECOMMENDED CAPITAL EQUIPMENT -

CPRA MISSISSAUGA PLANT

ITEM	ESTIMATED COST
PHASE 1	
Blending Silos	\$125,000
Engineering	\$ 25,000
Contingency Total Phase 1	\$ 10,000
Total Phase 1	\$160,000
PHASE 2	
Industrial Conveyors	\$ 90,000
Magnets	\$ 10,000
Rigids Washer & Hydrocyclones	\$175,000
EPS Size Reduction Equipment	\$ 25,000
Engineering	\$ 10,000
Contingency Total Phase 2	\$ 50,000
Total Phase 2	\$360,000
PHASE 3	
Pelletizer	\$ 75,000
Grinder	\$ 50,000
Additive Feeders (if required)	\$100,000
Engineering	\$ 45,000
Total Phase 3	\$270,000
TOTAL	\$790,000

